rf MEMS Devices Compatible with SiGe and rf CMOS Processing

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Outline

- IBM approach to rf MEMS
- Switches
- Resonators and filters

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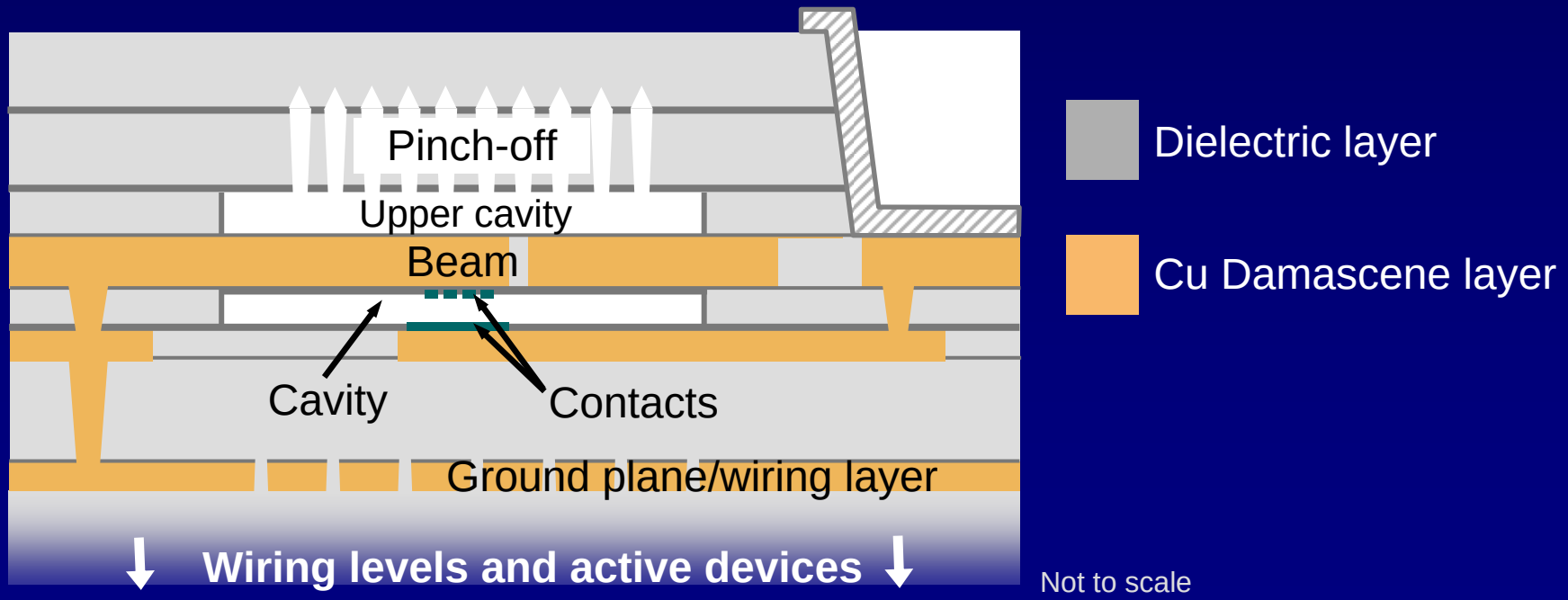
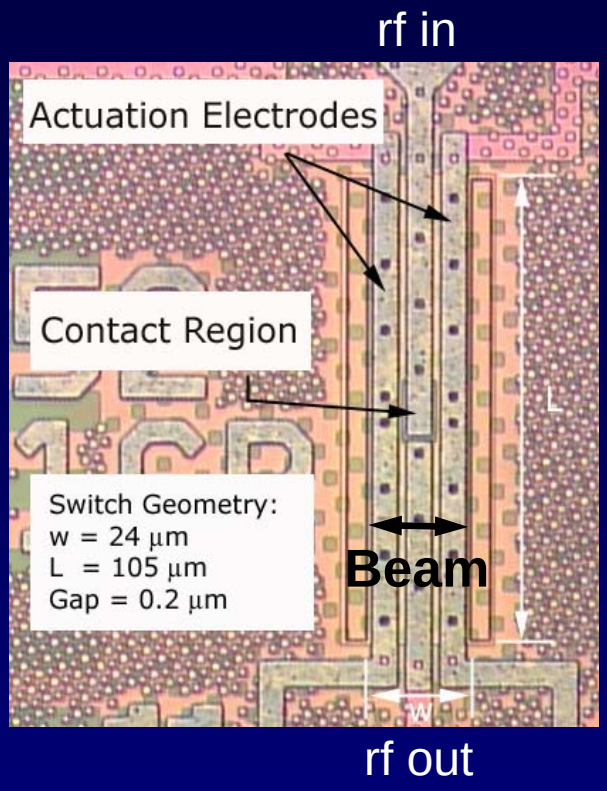
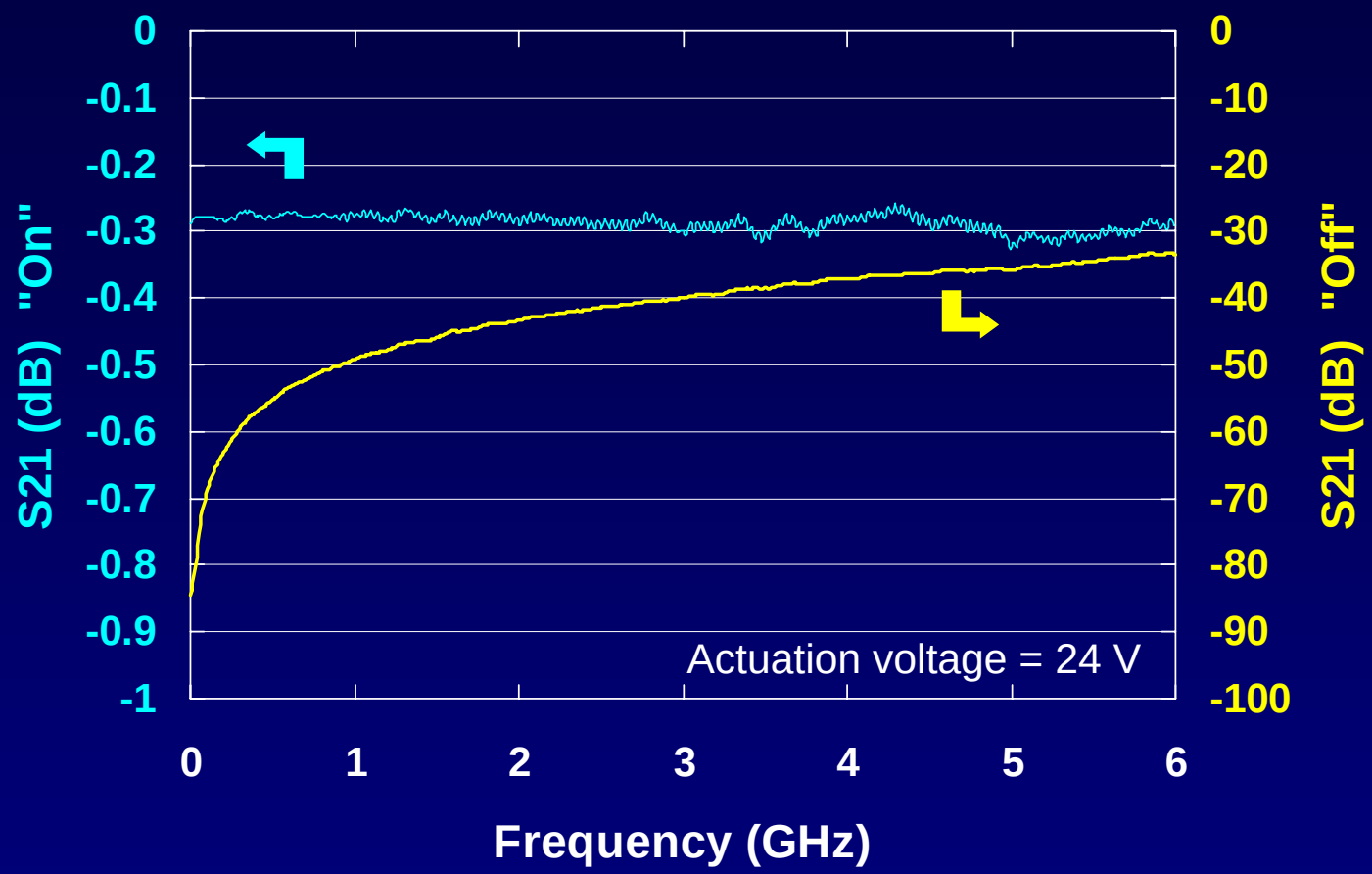
IBM's Approach to Integrated rf MEMS

- MEMS switches, resonators, and filters which can be integrated within the wiring levels for SiGe or analog CMOS IC's
  - Better performance, smaller size than discrete MEMS components
  - Potential for lower assembled cost as technology matures
  - Could enable novel radio architectures requiring many MEMS devices
- Devices built in a CMOS manufacturing environment with no new tools
- Process flow that allows fabrication of multiple types of devices
- Fully encapsulated devices at wafer level



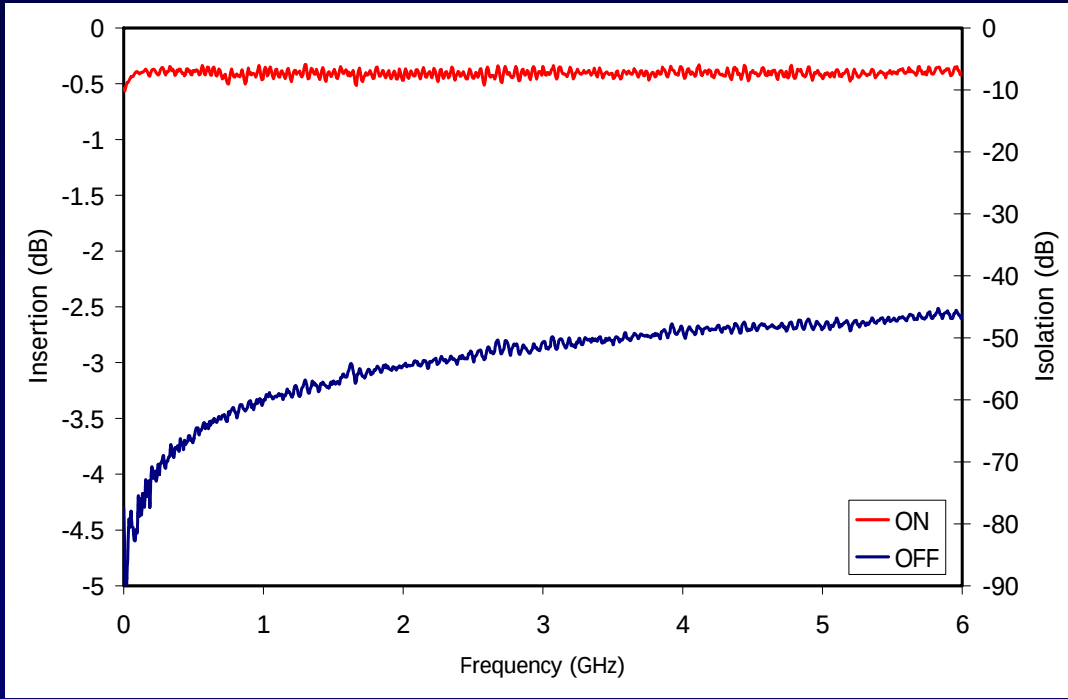
MEMS Switch Insertion Loss and Isolation

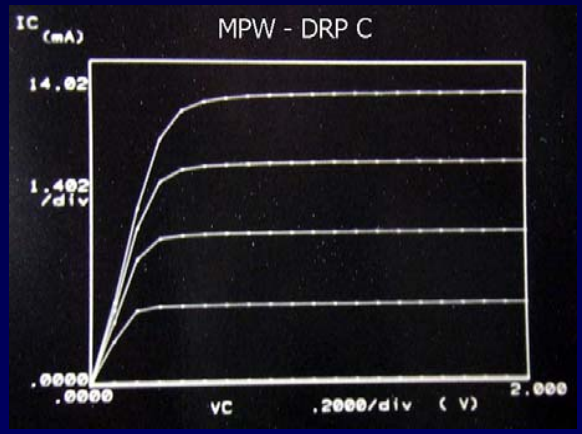




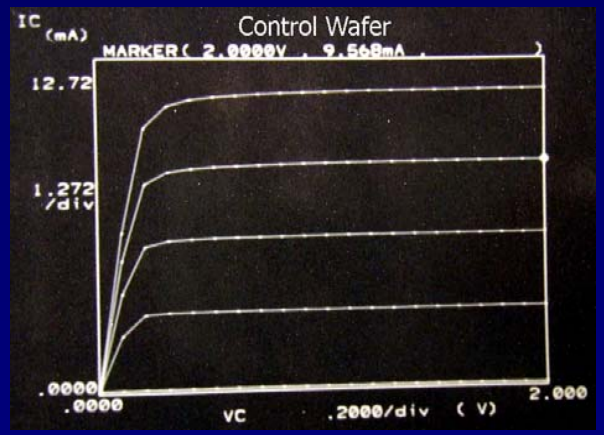
- Insertion loss 0.3 dB
- Isolation >32 dB up to 6 GHz

Switches Integrated on Functional SiGe IC's





Transistor on wafer with MEMS devices

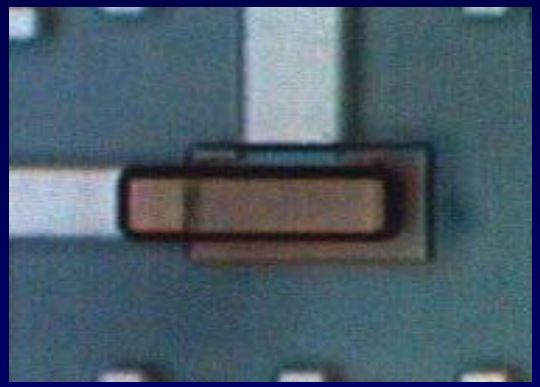


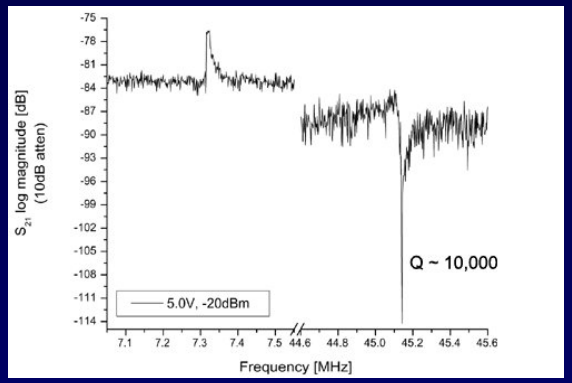
Transistor on wafer with no MEMS devices

- Working with a partner, switches were demonstrated on functional SiGe wafers
- No degradation of transistor characteristics due to MEMS processing
- Initiating work with other partners for a more extensive demonstration

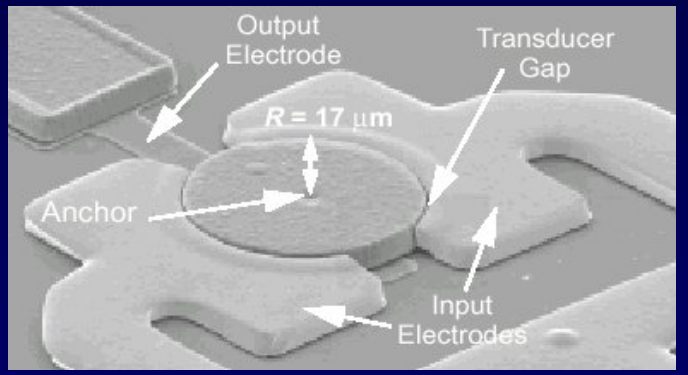
MEMS Resonators and Filters

- Electrostatically actuated mechanical resonators and filters do not scale well to GHz frequencies and have very high impedance



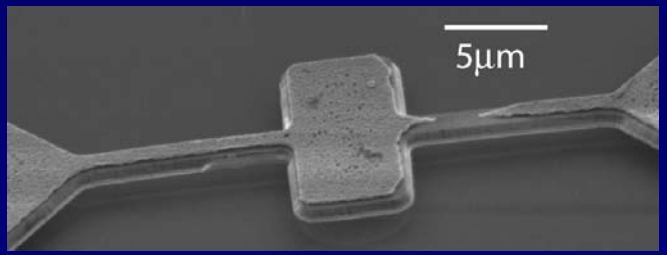


IBM - Cantilever beam

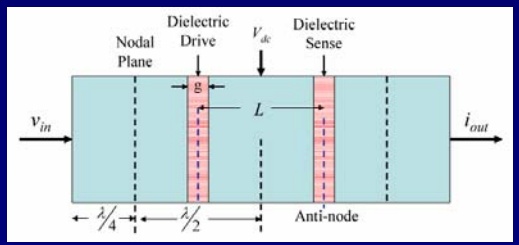


Nguyen - Disk resonator

- Evaluated attractive new technologies and have started fabricating new devices suitable for integration



Draper Labs – Piezoelectric bar resonator



Bhave et al. – Internal electrostatic transduction

- IBM strengths: Superior process and integration technology
  Ultra-high resolution lithography for tight frequency control
  Path to manufacturing

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